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RESEARCH ARTICLE

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Contribution to the floristic knowledge of eastern Irpinia and Vulture-Melfese area (Campania and Basilicata, southern Italy)

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Abstract

In order to improve the floristic knowledge of the Italian territory, we report the inventory of the taxa collected during the annual field trip of the working group for Floristics, Systematics and Evolution of the Italian Botanical Society held in 2015 in eastern Irpinia and Vulture-Melfese area (South Italy). The investigated territories are located in southern Apennines, along the border between the Campania and Basilicata administrative regions. These areas are scarcely known in terms of vascular flora. The floristic samplings were performed in 19 sites selected as representative of the local environmental diversity as regards to climate, litho-morphology and land-use.

The research led to the identification of 4,137 specimens of vascular plants, belonging to 815 species and subspecies, 399 genera, and 85 families. Among these taxa, 42 were endemic to Italy, 38 were included in the IUCN Red List of the Italian Flora, 28 were alien and 5 were cryptogenic in Campania and/or Basilicata administrative regions. Two taxa, *Aquilegia coerulea* (casual alien, native to North America) and *Lolium* ×*boucheanum* (native), were found to be new for Italy. On the basis of the available floristic literature the first one is also to be considered new for the European flora. At regional scale, we have found 18 taxa new for the Campania and 15 new for the Basilicata region. Finally, 10 taxa were confirmed for Campania. Data obtained during this study, confirmed the important role of a collaborative approach among botanists and the great relevance of these territories for plant diversity.

Keywords

alien species, botanists, endemics, herbaria, Italian vascular flora, new floristic records, plant diversity, southern Apennines

Introduction

The floristic knowledge of a territory is of considerable importance for scientific purposes and for conservation (Carli et al. 2018). In particular, the information concerning the endemic plants, such as their distribution and threats, are key elements for driv-

ing national conservation strategies (Brundu et al. 2017, Orsenigo et al. 2018). Wild vascular plants were recently used in some areas of Central-South Italy to evaluate the long-term changes in the floristic composition of vegetation of mountain ecosystems (Calabrese et al. 2018, Frate et al. 2018) and for risk assessment and management of soils polluted by industrial processes (Visconti et al. 2018). In the last two decades, the activities of the working group for Floristics, Systematics and Evolution of the Italian Botanical Society have greatly improved the knowledge about the vascular flora of some scarcely known areas of the Italian territory by using a collaborative approach (Peccenini et al. 2007, 2010, Peruzzi et al. 2011, Bouvet et al. 2018, Bartolucci et al. 2019a). This has been particularly fruitful in the southern part of Italian Peninsula (Conti et al. 2006, 2007, Santangelo et al. 2010, Bernardo et al. 2012, Wagensommer et al. 2014, Domina et al. 2015, Rosati et al. 2017, in press). Herein, we present the results of the floristic field excursion held in 2015 in eastern Irpinia and Vulture-Melfese area in southern Apennines (Italy). This research aims at improving the floristic knowledge of these areas which are located at the boundary between the administrative regions of Basilicata and Campania. According to Scoppola and Blasi (2005) and Blasi et al. (2011) these areas were included among those for which the available floristic data were absent or particularly scarce.

Materials and methods

Study area

The study area includes territories located within the border between the Campania and the Basilicata administrative regions in southern Italy (Fig. 1) falling within the administrative provinces of Avellino (municipalities of Aquilonia, Bisaccia, Monteverde and Trevico) and Potenza (municipalities of Atella, Bella, Melfi, San Fele and Rionero in Vulture). The administrative border between the two regions is represented by the Ofanto River, which separates the eastern Irpinia (Campania region) from the Vulture-Melfese area (Basilicata region). The altitude ranges from 275 m a.s.l. of Ofanto River, to 1407 m a.s.l. at the top of Mt. Santa Croce. From a climatic and biogeographic point of view, the investigated area is respectively intermediate between the Mediterranean and the Temperate region at the crossroads between the Apennine-Balkan, Italo-Tyrrhenian and Adriatic provinces (Rivas-Martínez et al. 2004).

Based on meteorological data retrieved from the station located at Monticchio Bagni (Rionero in Vulture, province of Potenza, 652 m a.s.l., Suppl. material 1: S1), the mean annual rainfall is 815 mm, and it is concentrated in the autumn-winter period with a maximum in November and a minimum in August. The annual average temperature is 13.7 °C, with the hottest months in summer (July-August) and the coldest in winter (December). The thermo-pluviometric diagram (Spicciarelli 2013, Suppl. material 1: S1) highlights a Mediterranean climate characterized by two months of summer drought period.

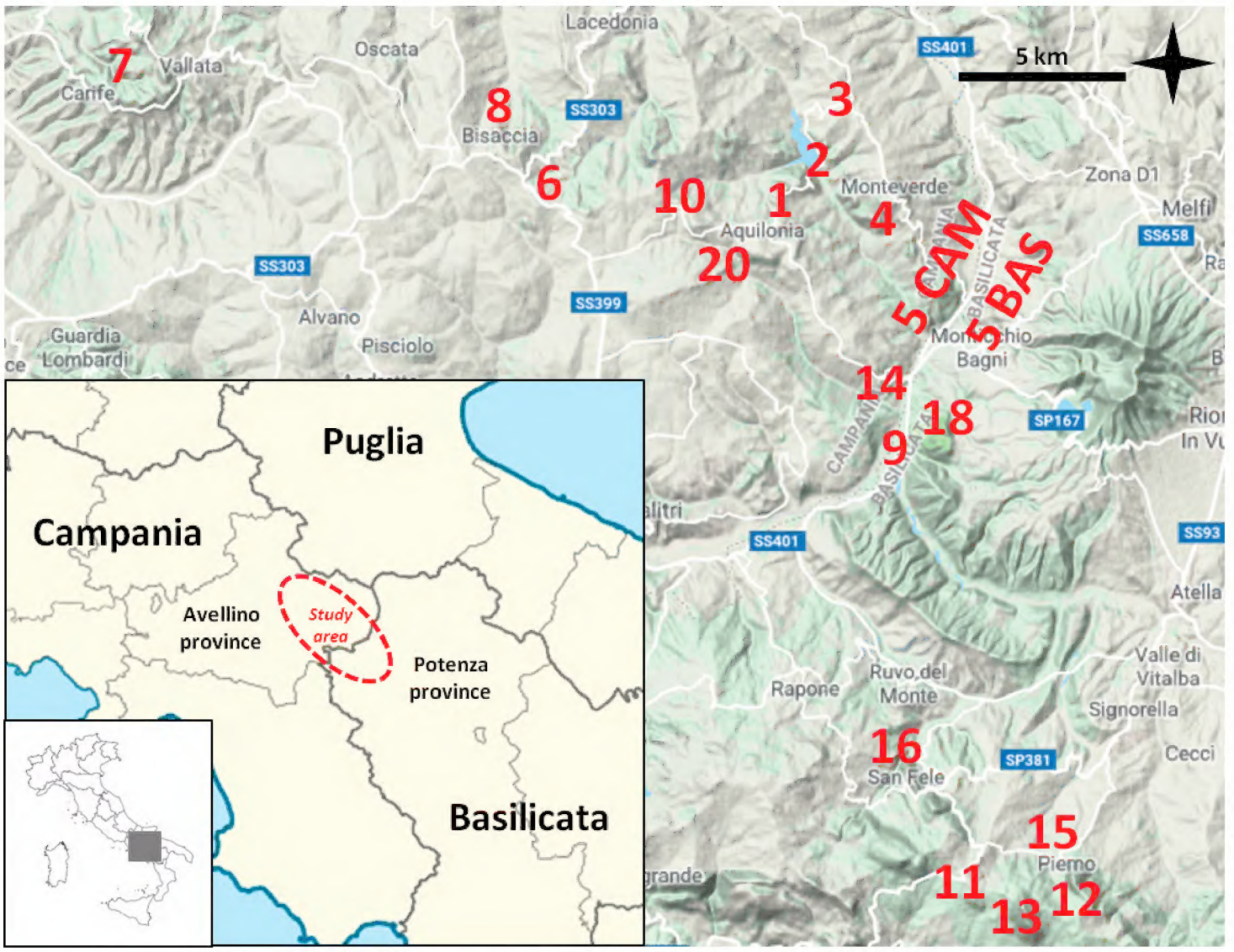

Figure 1. Location of study area and sampling sites (for details, see Suppl. materials 1: S2 and S3_1–S3_8).

The substrates of the study area are mainly composed of pelitic sediments (Flysch Rosso, Flysch Galestrino) and marginally of arenaceous sediments (Flysch Numidico), shaped in a hilly-mountainous landscape deeply dissected by the Ofanto River (Schiattarella et al. 2016). The Triassic-Tertiary units of the Lagonegrese Basin, here represented by thick flyschoid sediments overthrusted on previous carbonatic formations, occur only in the western part of the study area (Mt. Pierno).

The vascular flora of Irpinia and surrounding areas, was only partially explored between the end of the 19th and the beginning of the 20th century by Trotter (1905a, 1905b, 1906a, 1906b, 1908, 1909, 1910, 1913), Baccarini (1891), and Ferraris (1900, 1906).

Floristic survey

The research was coordinated by group of organisers (A. Stinca, L. Rosati, G. Chianese, G. D'Auria, S. Fascetti, M. Ravo, V. A. Romano and G. Salerno) who draw up the final floristic list with the contribution of all participants to the study. In order to maximize the identifiable taxonomic diversity within the surveyed area, 19 sites

of collection were selected as representative of the local diversity in terms of climate, litho-morphology, and land-use (Suppl. material 1: S2 and S3_1–S3_8). Some of these sites were included in protected areas, such as Natura 2000 sites or Vulture Regional Park (Suppl. material 1: S2). The aforementioned sites were intensively sampled during the period 3–6 June 2015 by 35 researchers (Suppl. material 1: S4). Further investigations were carried out only by the organizers on 18 December 2014, 22 April 2015, 13 and 27 May 2015 (Suppl. material 1: S2). In order to avoid destructive collections the sampling of the orchids was limited to very few individuals and more often substituted or supplemented by photographs. The floristic list was prepared in accordance to the protocol already used in previous contributions (e.g., Rosati et al. 2017, Bouvet et al. 2018, Bartolucci et al. 2019a). The taxonomic identification was carried out at first by the single collectors using standard floras (e.g., Tutin et al. 1968, 1972, 1976, 1980, 1993, Pignatti 1982) and other works (e.g., Christensen 1992, Whittemore 1997). Subsequently, the most critical specimens were revised during two specific workshops held at Portici (Library of Agriculture and Department of Agricultural Sciences of the University of Naples Federico II; 19 partecipants: L. Bernardo, L. Cancellieri, G. Chianese, G. Ciaschetti, F. Conti, G. D'Auria, R. Di Pietro, S. Fascetti, P. Fortini, C. Gangale, E. Lattanzi, S. Peccenini, E.V. Perrino, M. Ravo, F. Roma-Marzio, L. Rosati, G. Salerno, A. Scoppola, A. Stinca and A. Tilia) and Barisciano (Apennine Floristic Research Center; 10 partecipants: F. Bartolucci, L. Cancellieri, G. Ciaschetti, F. Conti, S. Fascetti, R. Pennesi, L. Rosati, G. Salerno, A. Scoppola and A. Stinca), on 3–5 March 2016 and 4–5 April 2016, respectively (Suppl. material 1: S5). Herbarium specimens belonging to the following critical groups were sent to specialists for revision: *Anchusella* and *Echium* (L. Cecchi, Florence), *Aquilegia* (E. Nardi, Florence), *Orobanche* (G. Domina, Palermo), *Pilosella* (G. Gottschlich, Tübingen), and Poaceae (E. Banfi, Milan). Finally, some doubtful specimens were also verified with the recent Flora d'Italia (Pignatti et al. 2017a, 2017b, 2018, 2019).

In the floristic list, taxa are alphabetically ordered. Nomenclature and taxa delimitation follow the checklist of Italian vascular flora (Bartolucci et al. 2018a, Galasso et al. 2018a) and recent updates (Bartolucci et al. 2018b, 2018c, 2019b, Galasso et al. 2018b, 2018c, 2019), with the exception of varieties and native hybrids which were not considered in the above-mentioned works. For some taxa one or more synonyms (preceded by the following symbols: "≡" for homotypic synonyms, i.e. for nomenclatural synonyms; "=" for heterotypic synonyms, i.e. for taxonomic synonyms; "–" for misapplied names) were reported in brackets to enhance understanding of the nomenclature updating. For each taxon, we reported the site of collection (using the codes given in Suppl. material 1: S2) and the herbaria where the specimens were deposited. For each taxon identified, at least one exsiccatum was prepared to be preserved in a public (Suppl. material 1: S6_1, acronyms follow to Thiers 2019) or private (Suppl. material 1: S6_2) herbarium.

Results

After the research, 4,137 specimens of vascular plants were identified, including 6 Orchidaceae documented only by digital photographs. These were classified in 814 species and subspecies, belonging to 399 genera and 85 families (Suppl. material 1: S7 and S8), together with 4 hybrids (*Crataegus ×media* Bech., *Lolium ×boucheanum* Kunth, *Medicago ×varia* Martyn and *Vitis ×koberi* Ardenghi, Galasso, Banfi & Lastrucci), and 1 cultivar of *Viola tricolor* L. subsp. *tricolor*.

Forty-two taxa (5.2% of the total flora detected, Table 1) were found to be endemic to Italy (Peruzzi et al. 2014, 2015, Bartolucci et al. 2018a), while 28 taxa (3.4%) were found to be alien for the study area (Bartolucci et al. 2018a, Galasso et al. 2018a).

Five taxa (0.6% of the total flora), *Brassica nigra* (L.) W.D.J.Koch, *Gladiolus italicus* Mill., *Melissa officinalis* L. subsp. *officinalis*, *Oxalis corniculata* L. and *Papaver rhoeas* L. subsp. *rhoeas*, were considered cryptogenic in the investigated area (Bartolucci et al. 2018a, Galasso et al. 2018a).

Forty-three units (5.3% of the total flora) were found to be new floristic records. In particular, *Aquilegia coerulea* E.James (casual alien) and *Lolium ×boucheanum* Kunth (native) are recorded for the first time in Italy.

As reported below, 18 and 15 taxa were found to be new for the regional flora of Campania (Table 2) and Basilicata (Table 3), respectively.

This research also allowed to confirm 10 taxa for the flora of Campania (Table 4).

Table 1. List of Italian endemic taxa surveyed in the eastern Irpinia and Vulture-Melfese area.

Acer cappadocicum Gled. subsp. *lobelii* (Ten.) A.E.Murray	*Koeleria lucana* Brullo, Giusso & Miniss.
Achillea rupestris Huter, Porta & Rigo subsp. *calcarea* (Huter, Porta & Rigo) Greuter	*Leontodon intermedius* (Fiori) Huter, Porta & Rigo
Aristolochia clusii Lojac.	*Linaria purpurea* (L.) Mill.
Armeria macropoda Boiss.	*Luzula sylvatica* (Huds.) Gaudin subsp. *sicula* (Parl.) K.Richt.
Artemisia campestris L. subsp. *variabilis* (Ten.) Greuter	*Myosotis sylvatica* Hoffm. subsp. *elongata* (Strobl) Grau
Campanula fragilis Cirillo subsp. *fragilis*	*Ononis oligophylla* Ten.
Carduus corymbosus Ten.	*Ophrys lucana* P.Delforge, Devillers-Tersch. & Devillers
Carduus nutans L. subsp. *perspinosus* (Fiori) Arènes	*Ophrys tenthredinifera* Willd. subsp. *neglecta* (Parl.) E.G.Camus
Centaurea centauroides L.	*Ornithogalum etruscum* Parl. subsp. *etruscum*
Cerastium tomentosum L.	*Ornithogalum exscapum* Ten.
Crocus biflorus Mill.	*Polygala nicaeensis* Risso ex W.D.J.Koch subsp. *peninsularis* Arrigoni
Crocus imperati Ten.	*Potentilla calabra* Ten.
Dianthus carthusianorum L. subsp. *tenorei* (Lacaita) Pignatti	*Pulmonaria vallarsae* A.Kern. subsp. *apennina* (Cristof. & Puppi) L.Cecchi & Selvi
Dianthus vulturius Guss. & Ten. subsp. *vulturius*	*Scorzonera hispanica* L. subsp. *neapolitana* (Grande) Greuter
Digitalis micrantha Roth ex Schweigg.	*Scorzonera villosa* Scop. subsp. *columnae* (Guss.) Nyman
Drymochloa drymeja (Mert. & W.D.J.Koch) Holub subsp. *exaltata* (C.Presl) Foggi & Signorini	*Silene italica* (L.) Pers. subsp. *sicula* (Ucria) Jeanm.
Echinops siculus Strobl	*Siler montanum* Crantz subsp. *siculum* (Spreng.) Iamonico, Bartolucci & F.Conti
Erysimum apenninum Peccenini & Polatschek	*Stipa austroitalica* Martinovský subsp. *austroitalica*
Euphorbia corallioides L.	*Thymus picentinus* (Lacaita) Bartolucci
Klasea flavescens (L.) Holub subsp. *cichoracea* (L.) Greuter & Wagenitz	*Tragopogon cupanii* Guss. ex DC.
Knautia calycina (C.Presl) Guss.	*Viola aethnensis* (Ging. & DC.) Strobl subsp. *splendida* (W.Becker) Merxm. & Lippert

Table 2. List of taxa new for Campania.

Achillea nobilis L. subsp. *nobilis*	*Mantisalca duriaei* (Spach) Briq. & Cavill.
Aquilegia coerulea E.James (casual alien)	*Medicago ×varia* Martyn
Aristolochia clusii Lojac.	*Medicago glutinosa* M.Bieb.
Bromus hordeaceus L. subsp. *longipedicellatus* Spalton	*Medicago muricoleptis* Tineo
Bromus hordeaceus L. subsp. *molliformis* (J.Lloyd ex Billot) Maire & Weiller	*Ophrys funerea* Viv.
Cachrys libanotis L.	*Papaver pinnatifidum* Moris
Festuca stricta Host subsp. *trachyphylla* (Hack.) Patzke ex Pils	*Philadelphus coronarius* L. (casual alien)
Ficaria verna Huds. subsp. *verna*	*Rosa deseglisei* Boreau
Lolium ×boucheanum Kunth (casual alien)	*Viola tricolor* L. subsp. *tricolor* cv. (casual alien)

Table 3. List of taxa new for Basilicata.

Achillea nobilis L. subsp. *nobilis*	*Pilosella ziziana* (Tausch) F.W.Schultz & Sch.Bip.
Aristolochia rotunda L. subsp. *rotunda*	*Polycarpon tetraphyllum* (L.) L. subsp. *tetraphyllum*
Bromus hordeaceus L. subsp. *longipedicellatus* Spalton	*Rosa deseglisei* Boreau
Koeleria pyramidata (Lam.) P.Beauv.	*Ruscus hypoglossum* L.
Lathyrus inconspicuus L.	*Saxifraga stolonifera* Curtis (casual alien)
Melissa officinalis L. subsp. *officinalis* (cryptogenic)	*Sonchus asper* (L.) Hill subsp. *glaucescens* (Jord.) Ball
Ornithogalum etruscum Parl. subsp. *etruscum*	*Thymus ×korbii* Ronniger. nothosusbp. *korbii*
Orobanche teucrii Holandre	

Table 4. List of taxa confirmed for Campania.

Catananche lutea L.	*Phalaris truncata* Guss. ex Bertol.
Chaerophyllum nodosum (L.) Crantz	*Rubia tinctorum* L. (casual alien)
Echinaria capitata (L.) Desf.	*Rumex thyrsoides* Desf.
Neslia paniculata (L.) Desv. subsp. *thracica* (Velen.) Bornm.	*Sclerochlo a dura* (L.) P.Beauv.
Phalaris aquatica L.	*Scorzonera hispanica* L. subsp. *neapolitana* (Grande) Greuter

Discussion

Data obtained shows that the eastern Irpinia and Vulture-Melfese area hosts a rich and interesting vascular flora. Except for *Aristolochia clusii*, *Digitalis micrantha*, *Ononis oligophylla* and *Ophrys tenthredinifera* subsp. *neglecta*, all the other Italian endemic taxa recorded are currently included in the IUCN Red List of the Italian Flora (Rossi et al. 2013, Orsenigo et al. 2018) together with the non-endemic *Orchis provincialis* Balb. ex Lam. & DC. (38 taxa, 4.7% of the total flora). As regards *Thymus picentinus*, the specimens collected during this study allowed Bartolucci and Mráz (2016) to confirm the occurrence of this taxon in Basilicata and to re-evaluate its taxonomic status.

Among the non-native plants, 18 taxa were neophyte and 8 were considered invasive in at least one of the administrative regions considered (*Ailanthus altissima*, *Amaranthus retroflexus*, *Crepis sancta* subsp. *nemausensis*, *Dysphania ambrosioides*, *Erigeron sumatrensis*, *Paspalum distichum*, *Robinia pseudoacacia* and *Veronica persica*).

A small population of *Aquilegia coerulea*, a neophyte native to North America (Whittemore 1997), was found in Aquilonia (Campania, Avellino province) in anthropogenic environments. These individuals much likely derived from nearby cultivated plants seeds. Based on our floristic literature research (e.g., Nardi 2017), this record is the first for

the European flora. *Lolium* ×*boucheanum*, that is the natural hybrid between *Lolium perenne* L. and *L. multiflorum* Lam., it was collected in a marginal area of Monteverde (Campania, Avellino province) and is reported for the first time in Italy. As far as *Bromus hordeaceus* subsp. *longipedicellatus*, before this study its Italian distribution was restricted to Lombardia and Sardegna (Bartolucci et al. 2018a). Our findings of this taxon in Campania and Basilicata (Table 2 and Table 3) are therefore to be considered the first records for the peninsular Italy. Likewise, the discovery of *Medicago glutinosa* in Campania (Table 2) confirms its presence in southern Italy. Indeed, this species was reported only for Lombardia, Veneto, Liguria and Toscana, while was no longer recorded for Emilia-Romagna, and is considered doubtful in Umbria, Marche and Calabria (Bartolucci et al. 2018a).

Saxifraga stolonifera too is currently recorded in Lombardia and Veneto, while it is no longer recorded in Liguria (Galasso et al. 2018a). Therefore, our record from Basilicata (Table 3) is the first for the peninsular Italy.

In addition to the 11 taxa that we confirmed for Campania (Table 4), the observations made during this study also allowed Scoppola et al. (2016) to confirm the presence of *Trifolium multistriatum* W.D.J.Koch for the same region.

Some of the specimens collected in the study area require additional investigations aimed to clarify their taxonomic status. For example, the complex of *Centaurea deusta* shows a considerable variability in Italy (Stinca et al. 2019a). The samples found are probably attributable to a new taxon under study.

In recent years, especially in Campania, some researchers have focused their attention on the territories that are not well known from a floristic point of view, such as the lowlands and urbanized areas (e.g., Stinca et al. 2016, 2017a, Motti et al. 2018, Croce et al. 2019, Stinca 2019, Stinca and Mei in press). Some studies were carried out also in well-known areas from a floristic point of view, that have allowed to update their flora (e.g., Rosati et al. 2012, Stinca and Motti 2013, Stinca et al. 2014, 2017b, 2019b, Salerno and Stinca 2017, Stinca 2017). The floristic exploration of eastern Irpinia and Vulture-Melfese area, although carried out in a few days and in a limited number of sampling localities, allowed recording a considerable amount of taxa. The high number of species of floristic interest found, as well as the numerous floristic novelties suggest a high biodiversity level of the eastern Irpinia and Vulture-Melfese area, which are areas poorly studied by botanists in the past but that deserve further research.

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Supplementary material I

Supplementary figures and tables 1–8

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Data type: species data

Explanation note: **Figure S1.** Thermo-pluviometric diagram of the representative station of Monticchio Bagni. **Table S2.** List of the sampling sites and relative details. **Figure S3(1–8).** Topographic maps of sampling. **Figure S4.** Botanists participating at the field survey in eastern Irpinia and Vulture-Melfese area. **Figure S5.** Playbills of the two workshops held in 2016 in Portici (Library of Agriculture and Department of Agricultural Sciences of the University of Naples Federico II) and Barisciano (Apennine Floristic Research Center) to revise the critical samples collected during the field survey in eastern Irpinia and Vulture-Melfese area. **Table S6_1.** Public herbaria in which the collected exsiccata are kept. **Table S6_2.** Private herbaria in which the collected exsiccata are kept. **Table S7.** Floristic list of taxa surveyed in the eastern Irpinia and Vulture-Melfese area with the number of sampling sites in bold. **Figure S8.** Orchids recorded in the eastern Irpinia and Vulture-Melfese area only by digital photographs.

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